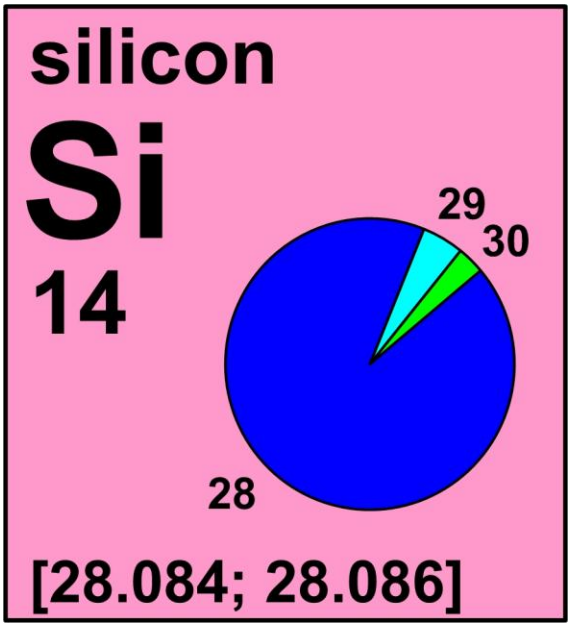
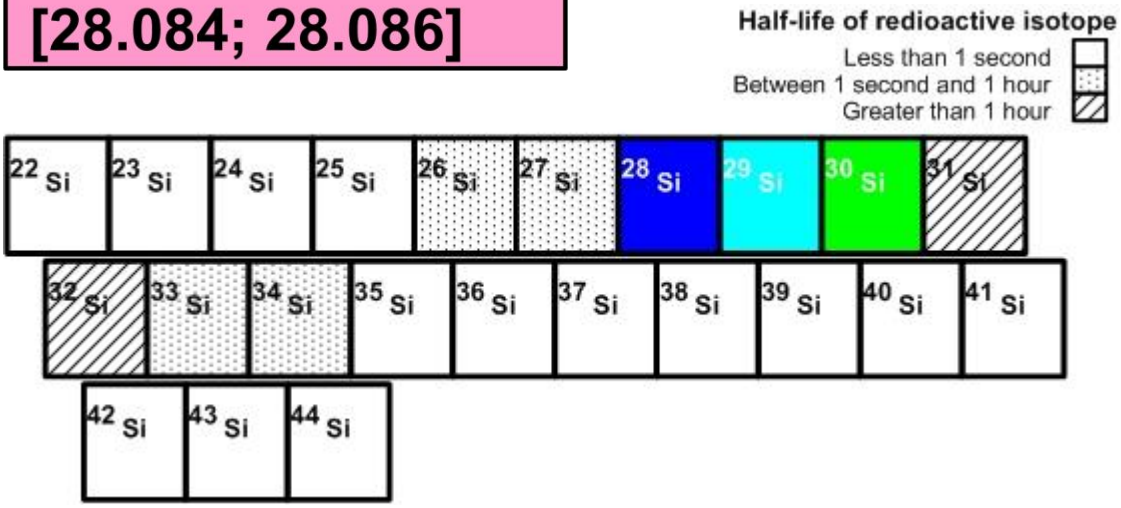
silicon



Stable isotope	Atomic mass*	Mole fraction
^{28}Si	27.976 926 53	0.922 23
^{29}Si	28.976 4947	0.046 85
^{30}Si	29.973 770 17	0.030 92

* Atomic mass given in unified atomic mass units, u.



Important applications of stable and/or radioactive isotopes

Isotopes in hydrology

1) Cosmogenic ^{32}Si is used to date glaciers. Glaciers are archives for global climate history because they contain a variety of proxies (imprints of past environmental conditions used to interpret paleoclimate) for climate forcing and climate response. Cosmogenic ^{32}Si is stored in glaciers and ice core samples can be analyzed using accelerator mass spectrometry to date the silicon.

Figure 1: Researchers in the New Zealand Southern Alps use cosmogenic ^{32}Si to help with paleoclimatic studies. Cosmogenic ^{32}Si is trapped in glaciers as they develop, ice cores can be extracted and ^{32}Si analyzed using accelerator mass spectrometry to help date regions of the glacier.

Isotopes in technology

1) At the University of Japan, the ITOH group has found a method for ^{29}Si to be used as a bit carrier to store and process information. The ITOH group wanted to progress further than just atomically manipulating elements and start manipulating the nanostructure of materials at an isotopic level, especially with semiconductors. Since silicon has three stable isotopes, they started manipulating these isotopes first by showing how the difference in the isotopes nuclear spin and mass has an effect on how an isotope can be manipulated on the isotopic level. Once they determined this, they successfully grew each isotope in bulk crystal (^{28}Si, ^{29}Si, and ^{30}Si).

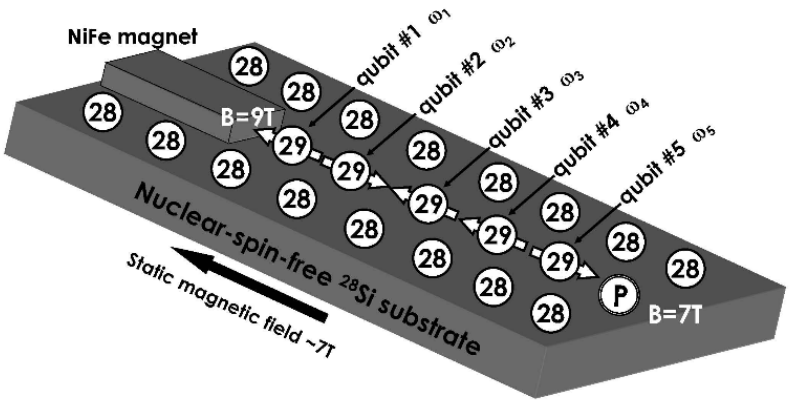


Figure 2: This is a picture of the silicon chip that uses ^{29}Si as a bit carrier to store information. ^{31}P is used for its nuclear spin and orbital spin to read the ^{29}Si quantum bits.

Isotopes in the environment

1) Diatoms need Si to build up their opaline shells and prefer ^{28}Si while taking up $Si(OH)_4$, which is the biologically available form of Si in the marine environment. This progressively enriches the surface waters with ^{29}Si and ^{30}Si.

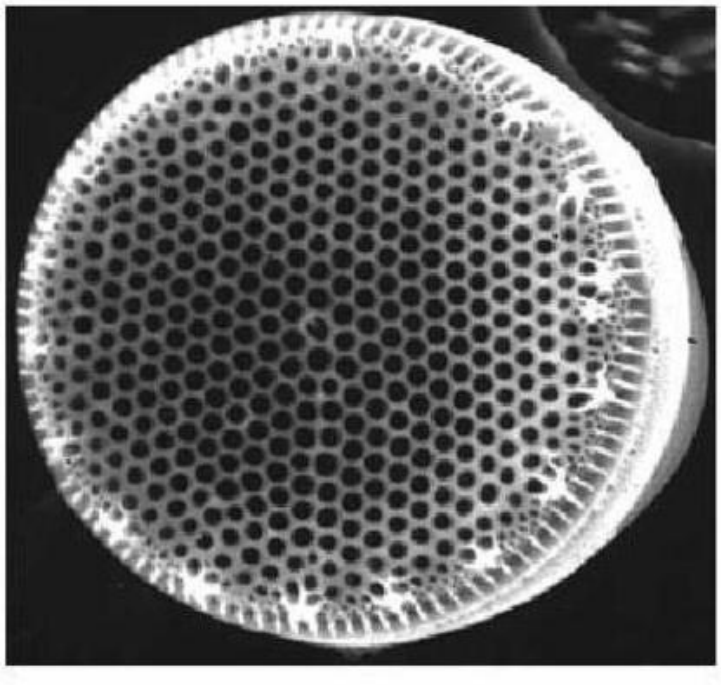


Figure 3: Diatom shell of Thalassiosira weissflogii (diameter of about 15 nm).

2) ^{32}Si-labeled silicic acid of high specific activity can be used to measure uptake rates of Si and estimate marine sedimentation of biogenic silica (diatoms and sea shells). By performing uptake kinetic experiments, the ^{32}Si activity can be measured as ^{32}P using Cerenkov counting and a Packard Tri-Card 1500 liquid scintillation analyzer.